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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

APPELLANTS:	Klotz et al.	GROUP ART UNIT: 2621
SERIAL NO.:	10/075,802	EXAMINER: Christopher. L. Lavin
FILED:	February 14, 2002	CONFIRMATION NO.: 8763
TITLE:	METHOD AND APPARATUS FOR PROCESSING A COMPUTED TOMOGRAPHY IMAGE OF A LUNG OBTAINED USING CONTRAST AGENT	

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APPELLANTS' MAIN BRIEF ON APPEAL

S I R:

In accordance with the provisions of 37 C.F.R. §41.37 Appellants herewith submit their main brief in support of the appeal of the above-referenced application.

REAL PARTY IN INTEREST:

The real party in interest is Siemens Aktiengesellschaft, a German corporation, assignee of the present application.

RELATED APPEALS AND INTERFERENCES:

There are no related appeals and no related interferences.

STATUS OF CLAIMS:

Claims 1-23 constitute all pending claims of the application. All of those claims stand rejected and are the subject of the present Appeal. No claim was added or cancelled during prosecution.

STATUS OF AMENDMENTS:

No Amendment was filed subsequent to the Final Rejection.

SUMMARY OF CLAIMED SUBJECT MATTER:

For diagnosis of pulmonary embolisms (PE), a CT angiography of the lung is implemented. Contrast agent is injected into the patient with a contrast agent pump. After pausing a few seconds, a spiral CT of the lung is implemented, a stack (series) of axial images, i.e. transverse tomograms, preferably representing body slices adjacent to one another and following one another in the direction of the longitudinal patient axis are acquired. The vessels filled with contrast agent can be clearly seen in CT images on the basis of the increase in density. The diagnosis ensues with reference to the axial images. Dependent on the orientation of the vessels relative to the plane of section, vessels are presented as bright lines or bright points in the so-called lung window. The overall vessel tree is tracked when "leafing" through the image stack and is checked for closures (thrombosis). Blockages or constrictions can be seen as dark matter in the vessel. Following the blockage, the vessel is no longer filled with contrast agent or is only partially filled with contrast agent and is therefore presented darker (p.1, l.4 - p.2, l.4). This standard technique has the problems that blockages can be overlooked, the hemodynamic effect of the thrombosis cannot be identified, blockages at small vessels cannot be recognized in the CT image due to the limited resolution, the degree of stenosis, i.e. the seriousness of the blockage, cannot be dependably determined, and other pathological changes may be erroneously diagnosed as a thrombo-embolic blockage (for example, closed bronchi). (p.2, l.9-12)

These problems are overcome or significantly alleviated by the method and apparatus embodied in the claims on appeal for processing an image obtained by computed tomography of a lung, wherein a CT image is generated using a contrast

agent, and a processed image is generated by presenting the pulmonary parenchyma pixels in false colors respectively corresponding to different HU (Houndsfield Unit) values*, and presenting the remaining image regions with gray scale values of the original image. (p.3, l.3-8)

The pre-condition for the diagnosis of pulmonary parenchyma is created as a result of determining the pulmonary parenchyma pixels and the coloring of the pulmonary parenchyma pixels, i.e. those pixels of the original image that represent the pulmonary parenchyma, and the presentation of the pulmonary parenchyma pixels in false colors respectively corresponding to different HU values. The diagnosis of PE can be substantially assisted by the involvement of the pulmonary parenchyma, since vessel closures cause a low blood flow, or a failure of the blood flow in the following tissue and thus involve a reduction of the contrast agent enhancement in the corresponding regions of the pulmonary parenchyma. The effects of the thrombo-embolic event are made directly visible. (p.3, l.9-17)

Fig. 1 shows an x-ray CT apparatus having a gantry 1 with a measurement opening 2 that is surrounded by a live ring 3 on which an x-ray radiator 4 and a detector system are attached. The detector system has a radiation detector fashioned in a known way and curved around an axis that preferably proceeds parallel to a system axis Z and through the focus of the x-ray radiator 4. The radiation detector 5 has a number of lines 5_1 through 5_n of detector elements, each forming a row of detector elements. A pyramidal x-ray beam RS that is indicated dot-dashed and that strikes the detector 5 emanates from the x-ray radiator 4. The

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* A discussion of the meaning of Houndsfield Units is included in the Argument.

gantry 1 having the x-ray radiator 4 and the radiation detector 5, and at least the support plate 7 of a support mechanism provided for the acceptance of an examination subject, for example of a patient P, are adjustable relative to one another in the direction of the longitudinal axis of the support plate 7 proceeding parallel to the system axis Z. This adjustment ensues by means of a notarized drive (not shown). In the CT apparatus according to Fig. 1, this is achieved by the support plate 7 being adjustably attached to the base 9 of the support mechanism 8 with a supporting part 10. The adjustment is in the direction of the system axis Z of the support plate 7, i.e. in the direction of the double arrow referenced z. (p.9, l.2-18)

For producing computed-tomographic exposures, the gantry 1 and the support plate 7 are moved relative to one another into a position wherein the support plate 7 extends through the measurement opening 2 of the gantry 1, and the patient P lying on the support plate 7 assumes such a position relative to the gantry 1 that a region of the patient P to be examined is covered by the x-ray beam RS. (p9, l.20-p.10, l.2)

For examinations with a contrast agent, a contrast agent injector 15 is provided with which contrast agent can be delivered to the patient P via a cannula 16. In the exemplary embodiment, the contrast agent injector 15, as indicated by a corresponding line, is controlled by the computer 11, namely both in view of the amount of contrast agent that is supplied to the patient P per time unit as well as in view of the beginning and the end of the delivery of contrast agent. (p.11, l. 6)

The image processing ensues in five steps, namely segmentation, vessel elimination, smoothing, color coding and image superimposition. (p.12, l.5-6)

A threshold-based algorithm is employed for segmenting the lung. Suitable algorithms are known in the art. (p/ 12, l.7-8)

The user sets a primary starting point in both lungs. Proceeding from these, a number of secondary starting points, for example seven secondary starting points, is determined, whereby three lie in y-direction above and three lie in y-direction below the primary starting point (Fig. 2). (p. 12, l. 15-18)

For example, the spacing between the starting points in the y-direction respectively amounts to five pixels; and x-coordinates correspond to those of the primary starting point. Seven possible starting points are determined from the starting points in exactly horizontal direction, i.e. x-direction. (p.12, l. 19-22) The search for a possible starting point in the x-direction in each lung proceeding from the respective starting point in the direction toward the edge of the image. (p.12, l. 22 - p.13, l.1) A point is defined as starting point whose CT value is at most equal to the aforementioned threshold and that is followed by a number of n pixels, for example n = 5 pixels, that lie above the threshold. The available starting point having the greatest distance in the x-direction from the appertaining starting point is utilized as the effective starting point of the contour finding, i.e., the outermost pixel that still lies within the CT value range for pulmonary parenchyma is selected as effective starting point. (p.13, l. 1-7)

The standard algorithm with n = 1 would occasionally fail in slices having a high density of vessels filled with contrast agents because all search paths end at vessel walls and not at the pleura. The assumption of an average vessel diameter of n pixels, for example n = 5, reduces the sensitivity of the algorithm. The starting

point having the greatest distance in x-direction from the appertaining initial point is utilized as the starting point of the contour finding. (p. 113, l.8-13)

The standard algorithm was also adapted in view of the actual contour finding of the lung (Fig. 3). The search for contour points proceeds counter-clockwise, proceeding from the effective starting point found in the way set forth above. The algorithm always considers the first three neighboring points in search direction and first determines the pixel having a value below the threshold as the next contour point. When the first of the three neighboring points is detected as a contour point, the search direction is modified to -90° compared to the original search direction. If none of the three pixels meets the criterion, the search direction is modified to +90° relative to the original search direction. In all other instances, the original search direction is retained unmodified. The algorithm is allowed to reverse the search direction and thus return on its own track. If the number of iterations exceeds a predetermined value, the contour search is aborted. (p.13, l. 14 - p.14, l.2)

In order to edit the data for the following smoothing operation, larger vessel structures and air paths are removed from the image during the course of the vessel elimination on the basis of HU value selection. A lower threshold HU_B and an upper threshold HU_V are prescribed; pixels below HU_B are identified as air paths, for example bronchia, and pixels above HU_V are identified as vessels. (p.14, l.13-17)

In order to obtain an optimum image impression, a balance must be found between the two objectives of removing optimally all vessels and retaining optimally many pulmonary pixels in the image. The optimum value for HU_V thereby differs from patient to patient and can even change within one and the same patient. A definition of HU_V as percentage is thus more universally valid, for which reason a

combination of threshold-based and percentage-based procedure is applied. Investigations have shown that the maximum number of removed pulmonary pixels is expediently limited to 28% of all pulmonary pixels, whereby HU_V is calculated such that the 28% limit is adhered to, whereas a fixed value of -990 HU is expedient for HU_B (Fig. 5). (p.14, l.18 - p.15, l.3)

The segmented image is subjected to a smoothing operation that is reformatted by linear interpolation during the course of an adaptive filtering in order to obtain isotropic pixel spacings. In detail, an adaptive sliding average value filtering is applied upon employment of an isotropic filter kernel (circular in the two-D case and spherical in the three-D case). When, as in the case of the described exemplary embodiment, no pulmonary parenchyma structures below a size of 5 mm are to be interpreted, a filter kernel having a diameter of 5 mm is preferably utilized (Fig. 6). In standard CT images, this corresponds to seven pixels. (p.15, l.4-11)

Given application of the filter, the middle pixel of the current kernel is replaced by the average value of all pixels of the respective kernel. Pixels that were removed in the preceding operations (segmentation, erosion, vessel elimination) are defined as invalid and do not contribute to the formation of the average value. (p.15, l.12-15)

The minimum proportion of valid pixels that must be present in a kernel in order to be able to produce a valid result of the formation of the average value is defined by the user. This minimum proportion is prescribed as a percentage, this being referred to below as the vessel factor. If the proportion lies below the limit value, the middle pixel is set as being invalid. Since all invalid pixels are replaced in the last processing step by the corresponding pixels of the original image, the vessel factor defines how many vessel structures and air paths will appear in the processed

pulmonary parenchyma region. A vessel factor 28% is preferably employed (Fig. 7). (p.15, l.16-23)

All pixels of the image that are invalid or lie outside the detected contour are set to 0. The image matrix and its binary mask are then separately convoluted. The convolution of the binary mask yields the plurality of valid pixels corresponding to the position of the value in the matrix. The vessel factor is taken into consideration in that the corresponding threshold is applied to the matrix, and all values below the threshold are set to 0. In order to obtain the filtered image, the convoluted image is divided by the convoluted mask, whereby the division is implemented element for element. When an element of the convoluted binary mask is 0, the result is set to invalid status. (p. 16, l.7-15)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL:

The following issues are presented for review on appeal:

whether the subject matter of claims 1-5, 11 and 15-23 would have been obvious to a person of ordinary skill in the field of processing computed tomography images under the provisions of 35 U.S.C. §103(a) based on the teachings of United States Patent No. 6,466,687 (Uppaluri et al.) in view of United States Patent No. 5,396,418 (Heuscher);

whether the subject matter of claims 6-10 would have been obvious to a person of ordinary skill in the field of processing computed tomography images under the provisions of 35 U.S.C. §103(a) based on the teachings of Uppaluri et al. and Heuscher, further in view of the teachings of United States Patent No. 5,351,305 (Wood et al.); and

whether the subject matter of claims 12-14 would have been obvious to a person of ordinary skill in the field of processing computed tomography images under the provisions of 35 U.S.C. §103(a), based on the teachings of Uppaluri et al. and Heuscher, further in view of the teachings of United States Patent No. 5,253,281 (Krauss).

ARGUMENT:

Rejection of Claims 1-5, 11 and 15-23 Under §103(a) Based on Uppaluri et al. and Heuscher

The Examiner stated the Uppaluri et al reference discloses the generation of a processed computed tomography image of a lung by generating pixels representing pulmonary parenchyma in false colors, and presenting the remaining pixels in the image with gray scale values. The Examiner stated this step is accomplished in the Uppaluri et al reference by overlaying the colored image onto the gray scale image. The Examiner acknowledged that the Uppaluri et al reference does not disclose the use of contrast agents, but the Examiner relied on the Heuscher reference as teaching the use of a contrast agent with a CT system to highlight vessels in the computed tomography image.

The Examiner concluded it would have been obvious to a person of ordinary skill in the relevant technology to use a contrast agent as taught by Heuscher in the method disclosed by Uppaluri et al. The Examiner stated that by using such a contrast agent, vessels will be brought out in the image, which would permit a viewer of the image generated according to Uppaluri et al to more easily identify the blood vessels.

Appellants respectfully submit the Examiner has extremely over-generalized the teachings of the Uppaluri et al. The Uppaluri et al references discloses a method

for automatically analyzing tissue differences, for example in CT exposures. The tissue differences are detected and segmented using different spatial frequencies in the image, as explicitly stated in the Uppaluri et al reference in the passage beginning at column 2, line 43.

With regard to the analysis of lung exposures, in the passage beginning at column 18, line 6, and in the table in column 18, Uppaluri et al show how different tissue types and pathologies can be recognized by the different structures, and therefore which areas of different characteristics spatial frequencies should be displayed with different colors. In the example of the image of a lung, this portion of the Uppaluri et al reference describes analysis of the spatial frequencies of the CT image so as to be able to show portions of the lung with different colors, dependent on a tissue structure of a lung. Because the Uppaluri et al reference define the colors based on the spatial frequencies, there is not necessarily any relationship between the HU value that is associated with a particular pixel, and the color with which that pixel will be displayed.

Houndsfield Units (HU) are standardly used in the processing of computed tomography images. Each pixel in a computed tomography image, for image processing (computational) purposes, is given a so-called CT number, which is a product of the x-ray attenuation coefficient of the tissue represented by the pixel, and a scaling factor. The scaling factor is obtained from the Houndsfield scale, so that a pixel representing water always has a CT number of zero, a pixel representing bone always has a CT number of +1000, and a pixel representing air always has a CT number of -1000. The Houndsfield scale thus has 2000 divisions, with each division being referred to as a Houndsfield number along the scale. As discussed below, the

use of Houndsfield Units or Houndsfield numbers to designate the false color representation allows the false colors to be shown with relatively fine precision, since 2000 Houndsfield Units are available for determining (setting) the respective false colors.

The Heuscher reference is but one of many hundreds, if not thousands of references that provide the well known teaching that a better representation of the coronary arteries in a CT image of the heart can be achieved by the use of a contrast agent.

Therefore, a person of ordinary skill in the field of displaying medical image information, without having had the benefit of first reading Applicants' disclosure, would simply use the Uppaluri et al reference to analyze the spatial frequencies of the CT image of a lung, and show different portions of the image in different colors dependent on their tissue structure, as derived from the spatial frequency analysis, and would also understand that vessels can be enhanced if, in addition, a contrast agent is administered.

This is not the same as the method and apparatus disclosed and claimed in the present application, wherein no color designation or formation based on spatial frequency analysis is undertaken. Instead, the entirety of the pulmonary parenchyma is shown with false color representation, with the remaining pixels being indicated in the conventional manner as gray scale values. The vessels in the region of the lung are particularly enhanced as to their gray scale values by the additional administration of contrast agent. The false colors are displayed dependent on the respective HU values of the pixels. Since the HU values can be relatively finely analyzed, slight differences in the HU values will produce noticeable color

differences. In the present invention, any pixel that has the same HU value will be displayed with the same color, but this is not the case in the Uppaluri et al reference. Independent claims 1, 18 and 21 have been amended consistent with the above discussion to make clear that each pixel has an HU value associated therewith, as well as a gray scale value that is (as is conventional) dependent on the HU value of that pixel. Each of the independent claims also has been amended to make clear that, in the processed image, all of the pulmonary parenchyma pixels are displayed in false colors that respectively correspond to the different HU values of the pixels, with the remaining pixels (i.e., those that do not represent pulmonary parenchyma) being displayed with their conventional gray scale values. This display of the remaining pixels with conventional gray scale values allows the usual enhancement with a contrast agent to even further assist in providing informational content to the image, since vessels will be highlighted, in the usual manner, by the action of the contrast agent. Thus the processed image has the dual benefit of the false colors for the pixels representing pulmonary parenchyma, the colors being selected dependent on the respective HU values of the pixels, together with the enhanced vessel imaging, obtained by the use of a contrast agent, for the pixels that are represented with gray scale values.

In the Final Rejection, in response to the above arguments that were made during prosecution, the Examiner contested Appellants' statement that because the Uppaluri et al. reference defines the color based on the spatial frequencies, there is not necessarily any relationship between the HU value that is associated with a particular pixel, and the color with which the pixel will be displayed. The Examiner stated that the Uppaluri et al. reference teaches analyzing the HU values associated

with pixels in several ways, and then using the data to classify regions of interest. The Examiner cited column 18, lines 5-20 of the Uppaluri et al. reference as providing such a teaching. The Examiner noted Uppaluri et al. further states that the classified regions of interest are then colored, citing column 20, lines 5-17. Appellants, of course, acknowledge that these separate statements exist in the Uppaluri et al. reference, but submit that the statement in the Uppaluri et al. reference at column 20, lines 5-17 specifically refers to colors being assigned dependent on a probability value obtained from equation [30] in the Uppaluri et al. reference, and provides no teaching or suggestion to make use of HU values for that purpose.

Moreover, although Appellants acknowledge that the Uppaluri et al. processing procedure necessarily analyzes HU values (because, as noted above, the use of HU values is standard in computed tomography image reconstruction), Appellants find nothing in the passage cited by the Examiner at column 18, lines 5-20 that refers to the specific use of HU values to classify regions of interest. In fact, in the table that immediately follows the passage at column 18, lines 5-20 in the Uppaluri et al. reference, the only classification "measuring stick" that is mentioned is the use of gray levels. As discussed above, the use of HU values, instead of gray levels, allows a much finer false color representation to be made, since Appellants have had the insight to realize that gray levels are too "coarse" for many types of representations.

In addition, the Examiner in the Final Rejection encouraged the Appellants to include language in the independent claims to emphasize the arguments that, in the subject matter of the claims on appeal, the false colors are displayed dependent on

the respective HU values of the pixels, and that any pixel that has the same HU value will be displayed with the same color, in contrast to the Uppaluri et al. reference. Appellants respectfully submit that the independent claims already clearly set forth these features, since each of independent claims 1 and 18 explicitly states that each pixel has a HU value associated therewith and each pixel furthermore has grayscale associated therewith that is dependent on the HU value thereof, and each of claims 1 and 13 further explicitly states that *all* of the pulmonary parenchyma pixels are presented in false colors *respectively* corresponding to different HU values, with remaining pixels being presented in the grayscale values. Appellants are unable to determine how this explicit language in the independent claims could be interpreted in any manner other than the manner which the Appellants were "encouraged" by the Examiner to make clear in the claims.

Appellants respectfully submit the Examiner has not satisfied the high evidentiary standard required by the United States Court of Appeal for the Federal Circuit for the purpose of substantiating a rejection under 35 U.S.C. §103(a).

The Federal Circuit stated in *In re Lee* 227 F.3d 1338, 61 U.S.P.Q. 2d 1430 (Fed. Cir. 2002):

> "The factual inquiry whether to combine references must be thorough and searching. ...It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with."

Similarly, quoting *C.R. Bard, Inc. v. M3 Systems, Inc.,* 157 F.3d 1340, 1352, 48 U.S.P.Q. 2d 1225, 1232 (Fed. Cir. 1998), the Federal Circuit in *Brown & Williamson Tobacco Court v. Philip Morris, Inc.,* 229 F.3d 1120, 1124-1125, 56 U.S.P.Q. 2d 1456, 1459 (Fed. Cir. 2000) stated:

> [A] showing of a suggestion, teaching or motivation to combine the prior art references is an 'essential component of an obviousness holding'.

In *In re Dembiczak,* 175 F.3d 994,999, 50 U.S.P.Q. 2d 1614, 1617 (Fed. Cir. 1999) the Federal Circuit stated:

> Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references.

Consistently, in *In re Rouffet,* 149 F.3d 1350, 1359, 47 U.S.P.Q. 2d 1453, 1459 (Fed. Cir. 1998), the Federal Circuit stated:

> [E]ven when the level of skill in the art is high, the Board must identify specifically the principle, known to one of ordinary skill in the art, that suggests the claimed combination. In other words, the Board must explain the reasons one of ordinary skill in the art would have been motivated to select the references and to combine them to render the claimed invention obvious.

In *Winner International Royalty Corp. v. Wang,* 200 F.3d 1340, 1348-1349, 53 U.S.P.Q. 2d 1580, 1586 (Fed. Cir. 2000), the Federal Circuit stated:

> Although a reference need not expressly teach that the disclosure contained therein should be combined with another, ... the showing of combinability, in whatever form, must nevertheless be clear and particular.

Lastly, in *Crown Operations International, Ltd. v. Solutia, Inc.,* 289 F.3d 1367, 1376, 62 U.S.P.Q. 2d 1917 (Fed. Cir. 2002), the Federal Circuit stated:

> There must be a teaching or suggestion within the prior art, within the nature of the problem to be solved, or within the general knowledge of a person of ordinary skill in the field of the invention, to look to particular sources, to select particular elements, and to combine them as combined by the inventor.

Appellants respectfully submit the Examiner has not properly substantiated the rejection of independent claims 1 and 18 according to the above rigorous standards, based on the Uppaluri et al. and Heuscher references. Claims 2-5, 11

and 15-17 add further method steps to the non-obvious method of claim 1, and claims 19-23 add further structure to the non-obvious apparatus of claim 18, and therefore would not have been obvious to a person of ordinary skill in the field of processing computed tomography images for the same reasons discussed above in connection with the independent claims.

Rejection of Claims 6-10 Under §103(a) Based on Uppaluri et al. and Heuscher and Wood et al.

The Examiner relied on the Wood et al. reference as teaching performing a smoothing operation on a CT image using a smoothing filter. Appellants do not disagree that the Wood et al. reference provides such a teaching, but for the reasons discussed above in connection with the Uppaluri et al. and Heuscher references, even if the Uppaluri et al. reference in combination with Heuscher were further modified in accordance with this teaching of Wood et al., the subject matter of claims 6-10, which depend from independent claim 1, still would result. Claims 6-10, therefore would not have been obvious to a person of ordinary skill in the field of processing computed tomography images based on the teachings of Uppaluri et al., Heuscher and Wood et al., for the same reasons discussed above in connection with claim 1.

Rejection of Claims 12-14 Under §103(a) based on Uppaluri et al., Heuscher and Krauss

The Examiner relied on the Krauss reference as teaching that a grayscale x-ray image can be windowed in order to display the image using a full brightness range. Appellants do not disagree that the Krauss reference provides such a teaching, but even if the Uppaluri et al./ Heuscher combination were further modified in accordance with this teaching, Appellants respectfully submit the subject matter of

claims 12-14, which embody the subject matter of claim 1 therein, still would not result. Claims 12-14, therefore, would not have been obvious to a person of ordinary skill in the field of processing computed tomography images under the provisions of 35 U.S.C. §103(a), based on the teachings of Uppaluri et al., Heuscher and Krauss.

CONCLUSION:

For the foregoing reasons, Appellants respectfully submit the Examiner is in error in law and in fact in rejecting claims 1-23 based on the teachings of the above references. Reversal of these rejections is therefore proper, and the same is respectfully requested.

This Brief is accompanied by a check for the requisite fee in the amount of $500.00.

Submitted by,

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CERTIFICATE OF MAILING

I hereby certify this correspondence is being deposited with the United States Postal Service as First Class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on July 14, 2006.

Steven H. Noll

STEVEN H. NOLL

CLAIMS APPENDIX

1. A method for processing a computed tomography image comprising the steps of:

obtaining a computed tomography image of a lung of a subject with contrast agent administered to the subject so as to affect said image, said image being comprised of pixels each having a Houndsfield Unit (HU) value associated therewith and each having a gray scale associated therewith dependent on the HU value thereof;

determining pixels representing pulmonary parenchyma in said image, as pulmonary parenchyma pixels; and

generating a processed image by presenting all of said pulmonary parenchyma pixels in false colors respectively corresponding to different HU values, and presenting remaining pixels in said image in said gray scale values.

2. A method as claimed in claim 1 wherein the step of determining the pulmonary parenchyma pixels comprises applying a contour finding algorithm to said image and thereby separating said pulmonary parenchyma pixels from said remaining pixels.

3. A method as claimed in claim 1 comprising determining said pulmonary parenchyma pixels, together with pixels representing bronchia and vessels, based on said HU values, and removing said pixels representing bronchia and vessels from said pulmonary parenchyma pixels.

4. A method as claimed in claim 3 wherein said pulmonary parenchyma pixels and said pixels representing bronchia and vessels comprise a totality of pixels, and comprising removing only a portion of said totality of pixels which does not exceed a predetermined maximum percentage of said totality of pixels.

5. A method as claimed in claim 4 comprising classifying the removed pixels as invalid pixels.

6. A method as claimed in claim 5 comprising subjecting a region of said image containing said pulmonary parenchyma pixels to a smoothing operation and excluding said invalid pixels from said smoothing operation.

7. A method as claimed in claim 6 comprising conducting a sliding averaging of said pixels in said region containing said pulmonary parenchyma pixels as said smoothing operation.

8. A method as claimed in claim 6 comprising selecting only a plurality of pixels, from among said pixels in said region containing said pulmonary parenchyma pixels, for smoothing in said smoothing operation.

9. A method as claimed in claim 8 comprising identifying a middle pixel in said plurality of pixels selected for said smoothing operation, and conducting said smoothing operation by generating an average value of said plurality of pixels selected for said smoothing operation, referenced to said middle pixel.

10. A method as claimed in claim 9 comprising designating a minimum proportion of valid pixels among said plurality of pixels selected for said smoothing operation, and setting said middle pixel to an invalid status if said minimum proportion is not reached.

11. A method as claimed in claim 5 comprising superimposing said pulmonary parenchyma pixels presented in false colors on said pixels presented in gray scale values, and replacing any pixels classified as invalid with corresponding pixels of said image in gray scale values.

12. A method as claimed in claim 1 comprising subjecting said pulmonary parenchyma pixels presented in false colors and said remaining image regions presented in said gray scale values to respectively independent windowing operations.

13. A method as claimed in claim 12 comprising windowing the pulmonary parenchyma pixels presented in false colors dependent on a histogram of said pulmonary parenchyma pixels.

14. A method as claimed in claim 13 wherein said histogram has a center of gravity, and employing said center of gravity as a central value in said windowing of said pulmonary parenchyma pixels, and setting a width of a window in said windowing of said pulmonary parenchyma pixels to a fixed value of 100 HU.

15. A method as claimed in claim 1 comprising obtaining a plurality of computed tomography images of said lung comprising, in combination, volume data from said subject, and for each of said images in said plurality of images, determining said pulmonary parenchyma pixels and generating a processed image wherein the pulmonary parenchyma pixels are presented in false colors and wherein the remaining image regions are presented in said gray scale values.

16. A method as claimed in claim 15 comprising conducting a multi-planar image reconstruction of said volume data comprised of said plurality of images.

17. A method as claimed in claim 1 wherein said computed tomography image is a first computed tomography image and wherein said processed image is a first processed image, and comprising the additional steps of:

obtaining a second computed tomography image of said lung of said subject without said contrast agent effecting said second computed tomography image, said second computed tomography image being comprised of a plurality of pixels respectively having gray scale values associated therewith, and containing pixels representing pulmonary parenchyma, as pulmonary parenchyma pixels;

generating a second processed image by presenting all of_said pulmonary parenchyma pixels in said second computed tomography image in said false colors and presenting said remaining image regions in said second computed tomography image in said gray scale values; and

subtracting said first processed image and said second processed image from each other.

18. A computed tomography apparatus for processing a computed tomography image comprising:

a scanner with a contrast agent injector for obtaining a computed tomography image of a lung of a subject with contrast agent administered to the subject so as to effect said image, said image being comprised of pixels each having a Houndsfield Unit (HU) value associated therewith and each having a gray scale associated therewith dependent on the HU value thereof;

a processor for determining pixels representing pulmonary parenchyma in said image, as pulmonary parenchyma pixels;

a display connected to said processor; and

said processor generating a processed image wherein all of said pulmonary parenchyma pixels are presented in false colors respectively corresponding to different HU values, and remaining pixels in said image are presented in said gray scale values and causing said processed image to be displayed at said display.

19. A computed tomography apparatus as claimed in claim 18 wherein said computed tomography image is a first computed tomography image and wherein said processed image is a first processed image, and wherein:

said scanner obtains a second computed tomography image of said lung of said subject without said contrast agent affecting said second computed tomography image, said second computed tomography image being comprised of a plurality of pixels respectively having gray scale values associated therewith, and containing pixels representing pulmonary parenchyma, as pulmonary parenchyma pixels;

said processor generating a second processed image wherein all of said pulmonary parenchyma pixels in said second computed tomography image are presented in said false colors and remaining image regions in said second computed tomography image are presented in said gray scale values; and

said processor subtracting said first processed image and said second processed image from each other to obtain a resultant image, said processor causing said resultant image to be displayed on said display.

20. A computed tomography apparatus as claimed in claim 18 comprising a user interface, including said display, connected to said processor, said user interface having an actuatable operating element for implementing the determination of pixels representing pulmonary parenchyma in said image and the display of said processed image.

21. A workstation for processing a computed tomography image of a lung of a subject with contrast agent administered to the subject so as to affect said image, said image being comprised of pixels each having a Houndsfield Unit (HU) value associated therewith and each having a gray scale value associated therewith dependent on the HU value thereof, said workstation comprising:

a processor for determining pixels representing pulmonary parenchyma in said image, as pulmonary parenchyma pixels;

a display connected to said processor; and

said processor generating a processed image wherein all of said pulmonary parenchyma pixels are presented in false colors respectively corresponding to different HU values, and remaining pixels in said image are presented in said gray scale values, and said processor causing said processed image to be displayed on said display.

22. A workstation as claimed in claim 21 wherein said computed tomography image is a first computed tomography image and wherein said processed image is a first processed image, and wherein said processor is supplied with a second computed tomography image of said lung of said subject without said contrast agent affecting said second computed tomography image, said second computed tomography image being comprised of a plurality of pixels respectively having gray scale values associated therewith, and containing pixels representing pulmonary parenchyma, as pulmonary parenchyma pixels, and wherein said processor generates a second processed image wherein all of said pulmonary parenchyma pixels in said second computed tomography image are presented in said false colors and remaining image regions in said second computed tomography image are presented in said gray scale values, and wherein said processor subtracts said first processed image and said second processed image from each other to obtain a resultant image and causes said resultant image to be displayed on said display.

23. A workstation as claimed in claim 21 comprising a user interface, including said display, connected to said processor, said user interface having an actuatable operating element for implementing the determination of pixels representing pulmonary parenchyma in said image and the display of said processed image.

EVIDENCE APPENDIX

Attachment A: Figs. 1, 2 and 3 of the application as originally filed.

Attachment B: United States Patent No. 6,466,687 (Uppaluri et al.) - cited in March 8, 2006 Final Rejection

Attachment C: United States Patent No. 5,396,418 (Heuscher) - cited in March 8, 2006 Final Rejection.

Attachment D: United States Patent No. 5,351,305 (Wood et al.) - cited in March 8, 2006 Final Rejection.

Attachment E: United States Patent No. 5,253,281 (Krauss) - cited in March 6, 2006 Final Rejection.

RELATED PROCEEDINGS APPENDIX

None.

CH1\ 4627972.1

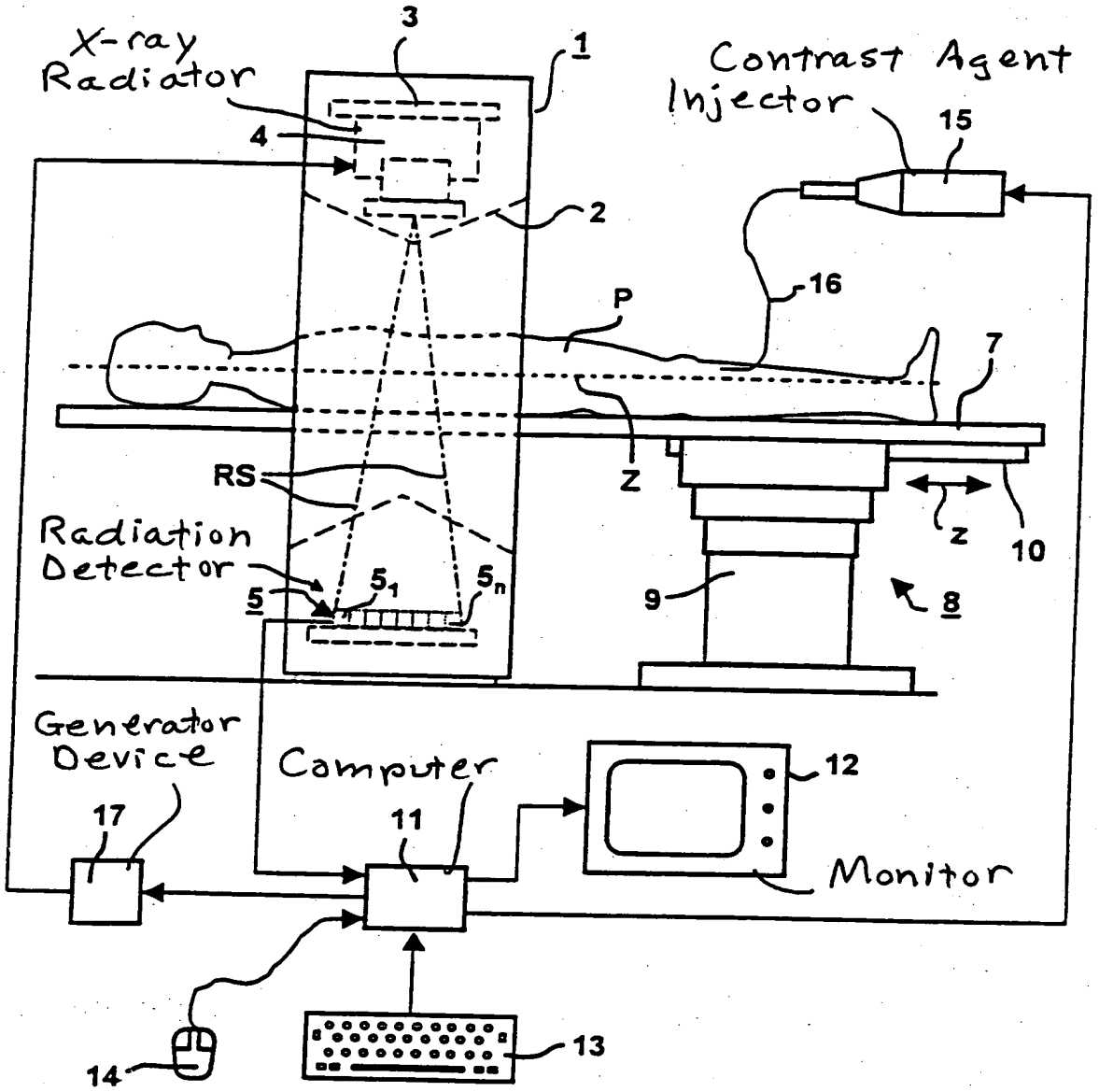
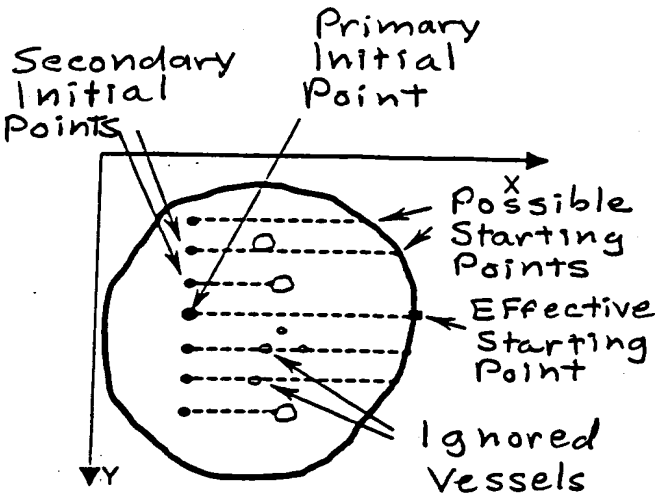


FIG 1

ATTACHMENT "A"


Secondary Initial Points
Primary Initial Point
X
Possible Starting Points
Effective Starting Point
Ignored Vessels
Y

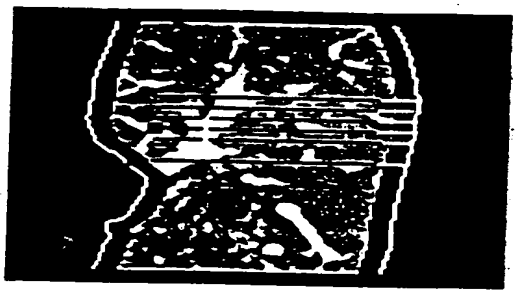


FIG 2

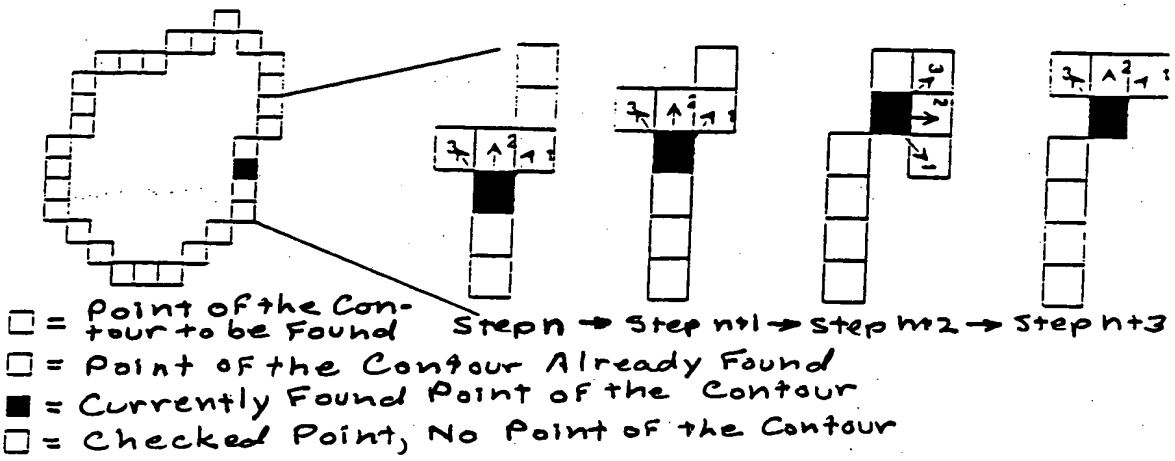

Step n
Step n+1
Step n+2
Step n+3
= Point of the Contour to be Found
= Point of the Contour Already Found
= Currently Found Point of the Contour
= Checked Point, No Point of the Contour

FIG 3

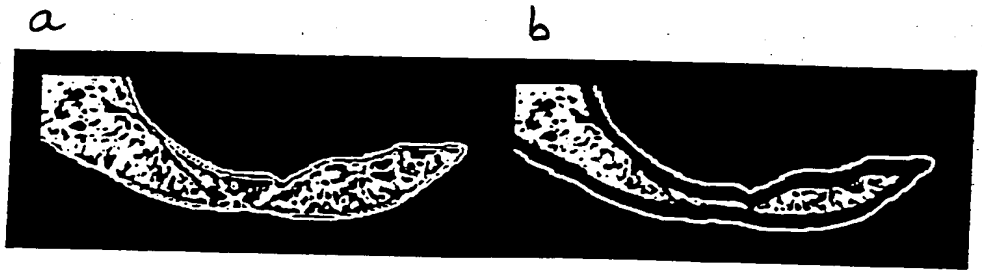


FIG 4

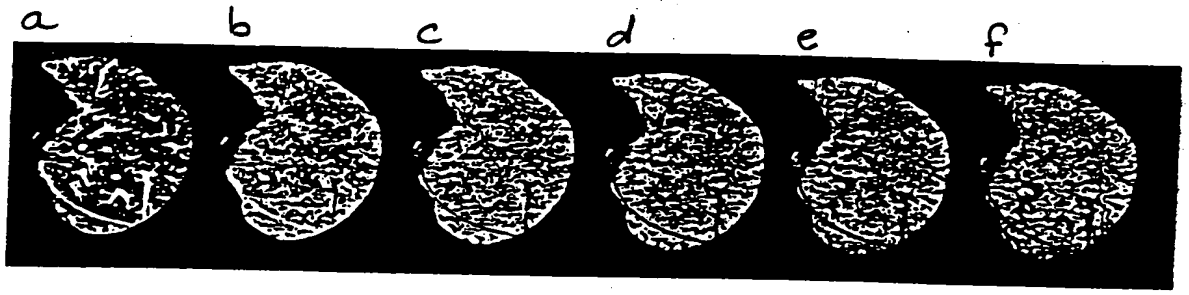


FIG 5

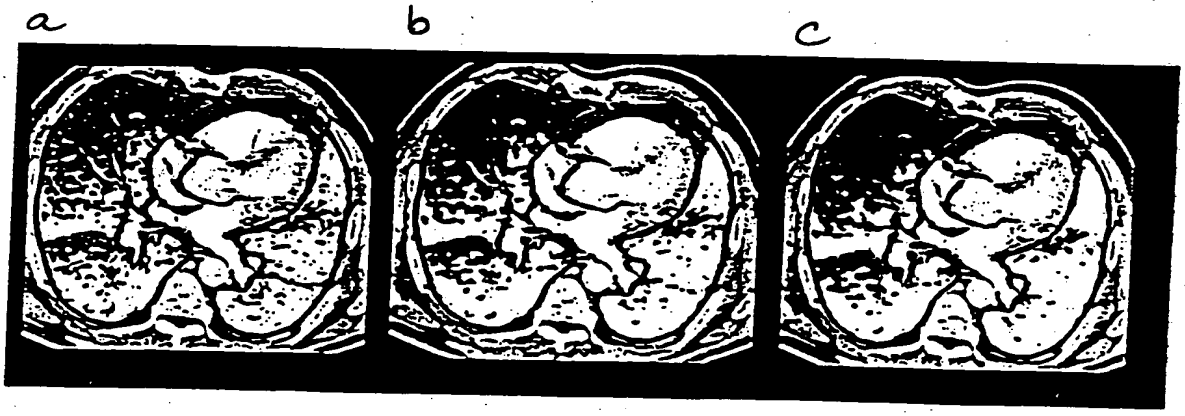


FIG 6

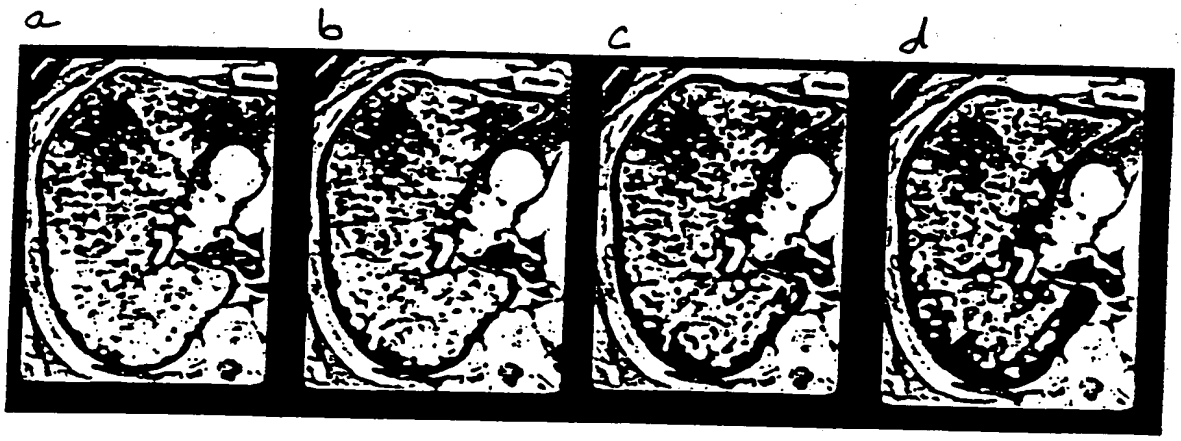


FIG 7

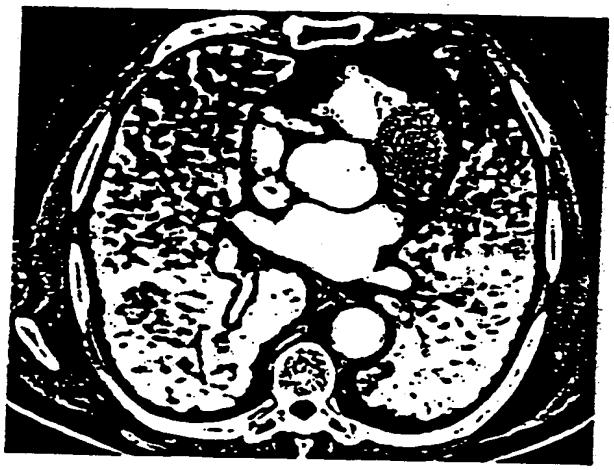


FIG 9

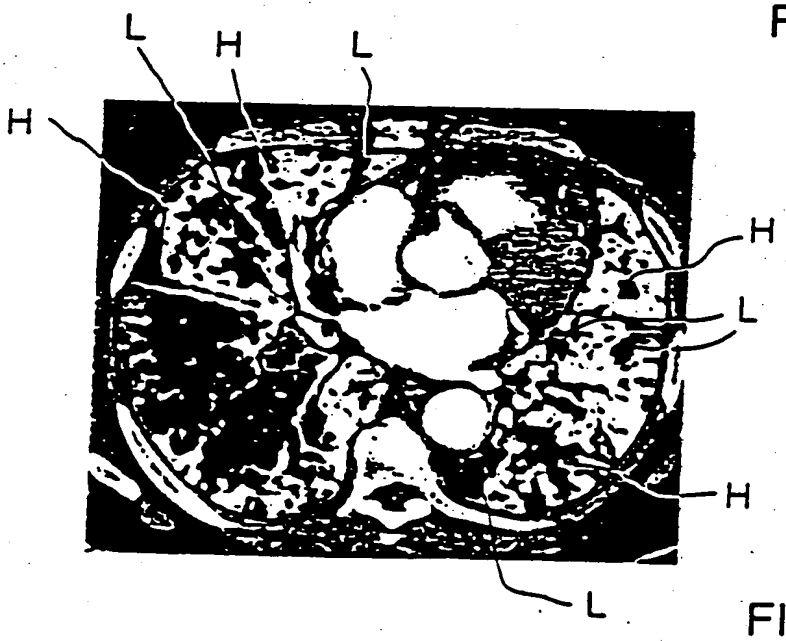


FIG 10

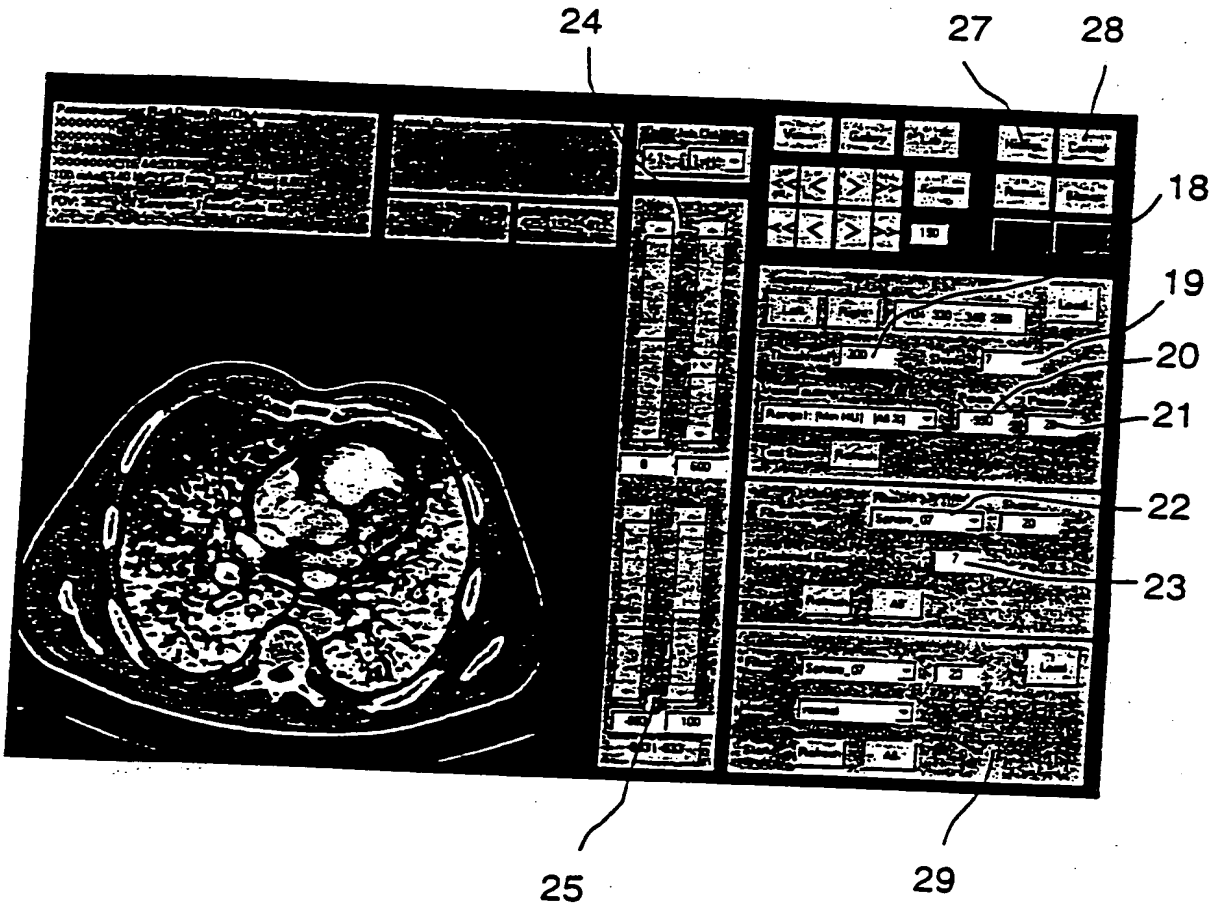


FIG 8

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